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(54) A combustion system and a method for operating a combustion system

(57) The combustion system (1) comprises a furnace (2) with main burners (3), a mill (4) for milling a solid fuel, a vapour separation system (7), a first line (8) for removing a fuel rich stream from the vapour separation system (7) and supply it to the main burners (3), a second line (9) for removing a fuel lean stream from the vapour separation system (7). The combustion system (1) further has a cooler (12) fed by the second line (9) for cooling at least the solid particles and a storage silo (13) connected downstream of the cooler (12), for collecting at least the solid particles cooled at the cooler (12).

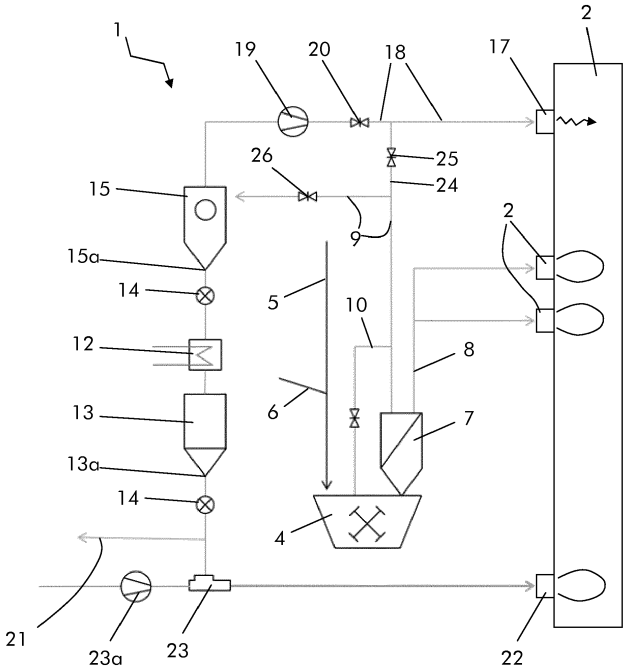

Fig. 1

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Description

TECHNICAL FIELD

[0001] The present invention relates to a combustion system and a method for operating a combustion system. The combustion system can for example be a part of a boiler of a power plant for electric energy production, other applications are anyhow possible. In addition the combustion system is used in connection with a solid fuel, preferably highly reactive solid fuels after pulverization.

BACKGROUND

[0002] Power plants for production of electrical energy can be fired using different fuels, such as oil, gas or solid fuels. Among the different fuels, solid fuels give the advantage of low costs when compared to gas or oil.

[0003] In order to fire a solid fuel in a furnace, the solid fuel has to be pulverized and typically also dried.

[0004] WO84/01016 discloses a boiler having a coal fired furnace with burners supplied by a mill. A line diverts a part of the pulverized coal into a silo for storing it and using it in the same boiler at start-up, warm-up and low load stabilization.

[0005] Dry lignite utilization has the potential for a significant cost reduction by replacing oil and gas.

[0006] Dry lignite is anyhow very reactive and after pulverization and drying cannot be stored in a silo in order to use it for start-up, warm-up and low load stabilization.

[0007] The lack of stored dry lignite to use during start-up, warm-up and low load stabilization reduces the operational flexibility of a power plant fired with dry lignite and must thus be addressed.

[0008] The inventors have found a way to store pulverized dry lignite, for example to have it ready when needed according to the operating conditions of the power plant.

SUMMARY

[0009] An aspect of the invention includes providing a combustion system and a method for its operation that allow storing of pulverized dry lignite, for example to have the pulverized dry lignite ready when needed according to the operating conditions of the combustion system and/or to extract and use the pulverized dry lignite outside of the combustion system.

[0010] These and further aspects are attained by providing a combustion system and a method in accordance with the accompanying claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Further characteristics and advantages will be more apparent from the description of a preferred but non-exclusive embodiment of the combustion system and method, illustrated by way of non-limiting example in the accompanying drawings, in which:

Figure 1 shows a combustion system in an embodiment of the invention.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0012] With reference to the figure, it shows a combustion system 1 comprising a furnace 2 with one or more main burners 3. The main burners 3 are fed with solid fuel (pulverized dry lignite) by a mill 4 (for example a beater wheel mill) that is supplied with hot flue gas from a resuction duct 5 and raw lignite (i.e. lignite to be pulverized) via a chute 6. The mill 4 is in turn connected to a vapour separation system 7.

[0013] The vapour separation system 7 separates a fuel rich stream, rich in pulverized dry lignite, from a fuel lean stream containing gas and solid particles; in this case, the gas can comprise water vapour, carbon dioxide, carbon monoxide, non-combusted hydrocarbon, and the solid particles entrained fuel solid particles. Vapour separation systems are well known in the art, for example they can take advantage from centrifugal forces to separate solid particles from gas.

[0014] The combustion system has a first line 8, for removing the fuel rich stream from the vapour separation system 7 and for supplying the fuel rich stream to the main burners 3; the first line 8 is thus connected to the vapour separation system 7 and to the main burners 3.

[0015] The combustion system further has a second line 9 for removing the fuel lean stream (comprising gas and solid particles) from the vapour separation system 7. A recirculation line 10 with a valve is connected between the second line 9 and the mill 4.

[0016] The combustion system also has a cooler 12 fed by the second line 9 for cooling at least the solid particles and a storage silo 13 connected downstream of the cooler 12 for collecting the solid particles cooled at the cooler 12.

[0017] Preferably valves such as rotary valves 14 are provided upstream of the cooler 12 and/or downstream of the silo 13 and/or between the cooler 12 and the silo 13 for sealing the cooler 12 and/or silo 13 and regulating the flow of solid particles through the cooler 12 and silo 13 and regulating the amount of solid particles supplied by the silo 13.

[0018] The cooler 12 cools the pulverized (and very reactive) lignite in order to allow storage without or with a limited risk of self-ignition of the lignite.

[0019] Preferably also a separator 15 such as a cyclone is provided; the separator 15 is provided between the second line 9 and the cooler 12, for separating the gas from the solid particles of the fuel lean stream.

[0020] The separator 15 comprises an outlet 15a for the solid particles; the outlet 15a is connected to the cooler 12 usually via a rotary valve 14.

[0021] In addition, the furnace 2 can also comprise one or more vapour burners 17 and the combustion system can comprise a third line 18 between the separator 15

and the vapour burner 17 to remove gas from the separator 15 and supply it to the vapour burners 17.

[0022] The third line 18 has a fan 19 and a control valve 20 for promoting and regulating the flow through the line 18.

[0023] The storage silo 13 can have (but this is not mandatory) an outlet 13a connected typically via a rotary valve 14 to an extraction line 21, for removal and external utilization of the solid particles.

[0024] In addition or as an alternative to the extraction line 21, the outlet 13a of the storage silo 13 can be connected to one or more dry lignite burners 22 of the furnace 2.

[0025] In this case, a shoe valve 23 can be provided between the outlet 13a of the storage silo 13 and the dry lignite burners 22 and a fan 23a can be provided for supplying carrier gas (for example cold air) to transport the solid particles.

[0026] In addition, the combustion system can further comprise a fourth line 24 between the vapour separation system 7 and the vapour burners 17, for supplying the fuel lean stream to the vapour burners 17. The fourth line 24 is preferably connected to the second line 9 and has a valve 25. Additionally, the fourth line 24 can also be connected to the third line 18 (i.e. the fourth line 24 can be a bypass of the separator 15).

[0027] The operation of the combustion system is apparent from that described and illustrated and is substantially the following.

[0028] Raw lignite is supplied via the chute 6 together with hot flue gas into the mill 4. At the mill 4 the lignite is dried and pulverized and supplied to the vapour separation system 7, from which the fuel rich stream (rich in pulverized lignite) is supplied to the main burners 3, and the fuel lean stream is conveyed via the second line 9 into the separator 15 from which gas is supplied to the vapour burners 17 for combustion (usually without flame) in the furnace 2. The solid particles are supplied from the separator 15 to the cooler 12, where the solid particles are cooled, such that no self-ignition occurs when the pulverized dry lignite is stored. The cooled pulverized dry lignite is thus supplied into the silo 13 and stored therein.

[0029] According to the requirements, the pulverized dry lignite can be extracted from the silo 13 for external use via the line 21 or can be used in the furnace 2; in this respect the lignite can be forwarded through the shoe valve 23 to the dry lignite burner 22 for combustion in the furnace 2.

[0030] By an appropriate regulation of the valves 20, 25 and 26 (the valve 26 being located on the second line 9 downstream of the branching of the fourth line 24) and rotary valves 14, the combustion system can be operated in order to:

- supply all fuel rich stream and fuel lean stream into the furnace 2,
- store part or all of the of the solid particles entrained or contained in the fuel lean stream in the silo 13,
- supply all fuel rich stream and fuel lean stream into the furnace 2 and in addition also supply solid particles collected in the silo 13 to the furnace 2.

[0031] The operation of the combustion system according to the embodiment of the invention is thus particularly flexible without impairing safety.

[0032] The present invention also refers to a method for operating a combustion system.

[0033] The method comprises

providing a mixture of gas and pulverized fuel; this is done for example by providing the lignite via the chute 6 together via hot flue gas via the resuction duct 5,

separating the mixture in a fuel rich stream and a fuel lean stream, this can for example be done in a way known in the art in a vapour separation system 7,

combusting the fuel rich stream in a furnace 2,

cooling at least the solid particles of the fuel lean stream for example in a cooler 12,

storing at least the solid particles of the fuel lean stream for example in a silo 13.

[0034] Advantageously, the gas is separated from the solid particles and then cooling and storing the solid particles occur after the separation, while the gas is combusted in the furnace.

[0035] The method also comprises extracting the solid particles for external utilization and/or combusting the solid particles in the furnace 2 and/or partly combusting the fuel lean stream in the furnace 2.

[0036] Advantageously, the combustion system according to the invention allows a reliable production and storage of dry lignite, a flexible utilization of the dry lignite during operation, the replacement of expensive fossil fuel (oil and/or gas) by dry lignite also at start up (because dry lignite is stored).

[0037] Naturally the features described may be independently provided from one another.

[0038] In practice the materials used and the dimensions can be chosen at will according to requirements and to the state of the art.

REFERENCE NUMBERS

[0039]

1	combustion system
2	furnace
3	main burner
4	mill
5	resuction duct
6	chute
7	vapour separation system
8	first line
9	second line
10	recirculation line (mill bypass)
12	cooler
13	storage silo
13a	outlet

14 rotary valve
15 separator
15a outlet
17 vapour burner
18 third line
19 fan
20 valve
21 extraction line
22 dry lignite burner
23 shoe valve
23a fan
24 fourth line
25 valve
26 valve

Claims

1. A combustion system (1) comprising
a furnace (2) with at least a main burner (3),
a mill (4) for milling a solid fuel,
a vapour separation system (7) connected to the mill (4),
a first line (8) for removing a fuel rich stream from the vapour separation system (7) and supply the fuel rich stream to the at least a main burner (3),
a second line (9) for removing a fuel lean stream from the vapour separation system (7), the fuel lean stream comprising gas and solid particles, **characterised by** further comprising
a cooler (12) fed by the second line (9) for cooling at least the solid particles,
a storage silo (13) connected downstream of the cooler (12) for collecting at least the solid particles cooled at the cooler (12).

2. The combustion system (1) of claim 1, **characterised by** comprising a separator (15) between the second line (9) and the cooler (12), for separating the gas from the solid particles, the separator (15) comprising an outlet (15a) for the solid particles connected to the cooler (12).

3. The combustion system (1) of claim 2, **characterised in that** the furnace (2) further comprises one or more vapour burners (17) and the combustion system further comprises a third line (18) between the separator (15) and the vapour burner (17) to remove gas from the separator (15) and supply it to the vapour burners (17).

4. The combustion system (1) of claim 3, **characterised by** comprising a fan (19) on the third line (18).

5. The combustion system (1) of claim 1, **characterised in that** the storage silo (13) comprises an outlet (13a) connected to an extraction line (21), for removal and external utilization of the solid particles.

6. The combustion system (1) of claim 1, **characterised in that** the furnace (2) further comprises one or more dry lignite burners (22), wherein the storage silo (13) comprises an outlet (13a) connected to the dry lignite burners (22).

7. The combustion system (1) of claim 6, **characterised by** comprising a shoe valve (23) between the outlet (13a) of the storage silo (13) and the dry lignite burners (22).

8. The combustion system (1) of claim 1, **characterised in that** the furnace (2) further comprises one or more vapour burners (17), the combustion system further comprising a fourth line (24) between the vapour separation system (7) and the vapour burners (17) for supplying the fuel lean stream to the vapour burners (17).

9. The combustion system (1) of claim 8, **characterised in that** the fourth line (24) is connected to the second line (9).

10. A method for operating a combustion system (1) having a furnace (2) with at least a main burner (3) for combusting a solid fuel, the method comprising
providing a mixture of gas and pulverized fuel,
separating the mixture in a fuel rich stream and a fuel lean stream, the fuel lean stream comprising gas and solid particles,
combusting the fuel rich stream in the furnace (2), **characterised by**
cooling at least the solid particles of the fuel lean stream,
storing at least the solid particles of the fuel lean stream.

11. The method of claim 10, **characterised by** separating the gas from the solid particles and then cooling and storing the solid particles.

12. The method of claim 11, **characterised by** combusting the gas in the furnace.

13. The method of claim 10, **characterised by** extracting the solid particles for external utilization.

14. The method of claim 10, **characterised by** combusting the solid particles in the furnace.

15. The method of claim 10, **characterised by** partly combusting the fuel lean stream in the furnace.

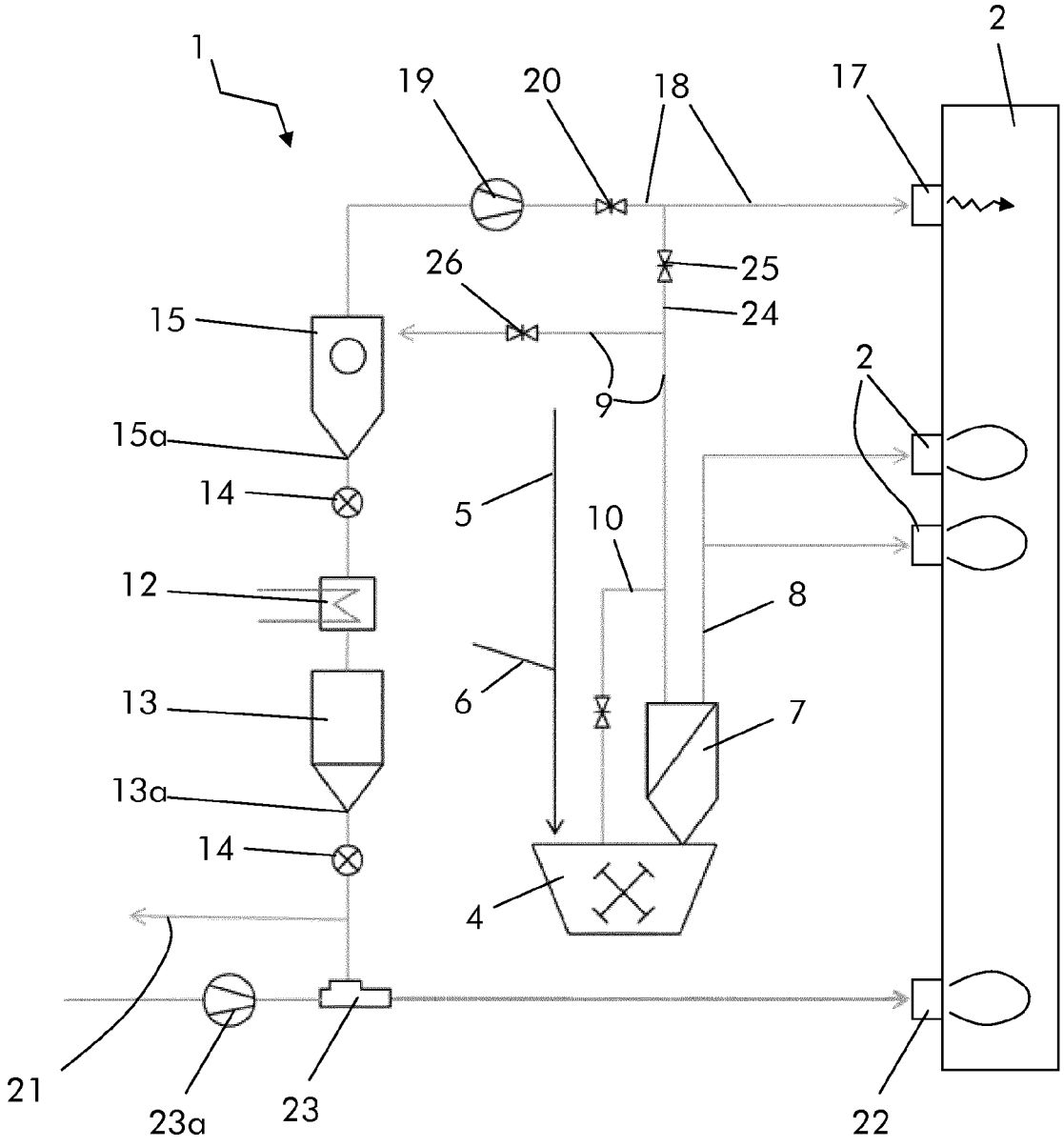
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Fig. 1

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EUROPEAN SEARCH REPORT

Application Number
EP 14 18 3121

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
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X : particularly relevant if taken alone
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